Freight villages: A literature review from the sustainability and societal equity perspective

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Abstract

The purpose of this study is to present a state-of-the-art literature review on Freight Villages from the sustainability and equity perspective, and discuss their impacts and place in the supply chain and logistics networks while focusing on the core concepts of freight transportation. With an understanding of the structure of freight villages, it is clear that they have potential for a number of merits with the increase in freight transportation activities. However, our review shows that current literature does not present satisfying evidence that these villages fulfill their purpose in terms of sustainability and social equity.

1. Introduction

A Freight Village (FV) is an area within which all activities relating to transport, logistics, and distribution of goods both at the domestic and international level are carried out by various operators (EUROPLATFORMS, 2000). Established outside the cities, these (logistics) complexes let the stakeholders perform value-added logistics activities not only by hosting them under the same roof, but also by creating a synergy between them; enabling coordination and collaboration. Current literature clearly states that addressing sustainability and equity issues are the starting points for establishing FVs (Wu et al. 2003, Boile et al. 2008, Higgins et al. 2011).

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According to Kapros et al. (2005), when FVs first appeared in the European continent (the first FV being located in the Paris region) in late 1960s in order to reduce traffic in cities, by freight *consolidation*, their main driver was urban freight transportation effectiveness. In 1970s, FVs started appearing in Italy and Germany, this time following the concept of extended inland rail/road intermodal terminals. In the 1980s and 1990s, the number of FVs continued to increase in the Central European countries (France, Germany, Italy, Netherlands, and Belgium) and the United Kingdom (Kapros et al. 2005). Between 1980s and 1990s, a promising aspect of FVs was the reduction in transportation costs due to the economies of scale, which started to gain more importance as competitiveness in the global business environment increased.

By late 1990s and early 2000s, these systems supported their stakeholders by means of facilitating *coordination*. It is also of no surprise that those during years, businesses started to appreciate the importance of *collaborative* action, as well as relevant concepts such as horizontal and vertical integration. Currently, in the first decades of the new millennium, acting sustainably is crucial for any decision maker, more than it ever was before. Social equity, which is an inseparable part of sustainability, is likewise vital. The world is ringing alarm bells and FVs are now in a different step of their evolution where they need to address issues related to sustainability and societal equity.

FVs have different purposes throughout the world, based on the varying organizations of the economies and demographic structures they serve. In the developing countries, FVs are regarded as an advantage for regional development, whereas in more developed parts of the world, they are a key ingredient for competitiveness, and/or the means for a more sustainable business (Altuntas et al., 2013). Based on an overall survey of the distribution of relevant studies in the literature, for which a detailed discussion will be provided in Section 4, a vast majority focuses on high-income economies and upper middle-income economies, which constitute more than 60% of the countries of the world. Studies focused on high-income countries consider FVs as a compulsory mechanism for competitiveness and an efficient business, whereas studies based on the upper middle-income economies point to the need for FVs as development drivers to achieve social equity (Bodaubayeva, 2015).

This study presents a review of the state-of-the-art literature on the profile and development of FVs with two purposes. First, it discusses the impacts of FVs and determines their corresponding

place in supply chain and logistics networks. Second, it questions the sustainability and social equity issues regarding FVs with specific focus on the freight transportation literature.

The remainder of this paper is organized as follows. Section 2 highlights the evolution of logistics and current logistics paradigms. For a better understanding of the evolution of Freight Villages, the growth of logistics and freight transportation is explained to better understand the capability and the existence of FVs throughout the world. In addition, Section 2 analyzes freight logistics activities with descriptive statistics to understand the ongoing activities and concepts around the globe in terms of freight transportation. Section 3 gives a description of an FV as a purposeful system. A summary of FV evolution, along with properties of FVs in the literature and the potential benefits a supply chain network can obtain from an FV, is also given in this section. We make use of a systematic review and analysis of the literature in order to point out research directions on the topic and provide the researchers with a comprehensive guide on the body of knowledge on FVs. Section 4 presents the systematic literature review and describes the application of the method as well as the outcomes of the review. In addition to these, nomenclature of FVs is also investigated. The impact of FVs on sustainability and equity is discussed in Section 5 along with a brief definition of the perception of sustainability in the paper. The last section gives the conclusion of the paper and points to important potential work areas.

2. Logistics and Freight Transportation

Just as in many other different industries, there have been major changes in transportation through time, especially in logistics activities and freight transportation. Throughout this evolution, the term *logistics* has evolved and the perception of logistics has changed with the term itself. Over more than the last two decades, markets of the world have come closer to each other and shrunk it into a village. Consequently, the complexity, scale, and speed of transportation activities have increased significantly. In addition to all these, as the producers' strategies focus more on outsourcing, the structure of supplier-consumer relationships have turned into a chain structure and later on into webs, which resulted in the need for a holistic view for understanding of such structures. Logistics constitutes an important part of business activities especially when operations are outsourced and/or a wide market is aimed.

While the term *logistics* was coined for the use of military activities for a long time, it has recently gained a more civilian structure under the concept of *business logistics*. During the 1960s, logistics

was solely understood as the physical distribution of goods, whereas by the end of the 1980s, inventory management concerns and *supply chain management* started to gain importance. Starting from the mid-1990s (particularly with the increase in the use of third party logistics), concepts of *consolidation* and *coordination* have become new trends (Rimienè et al. 2007). The Oxford Dictionary (2010) defines consolidation as "combination of (a number of things) into a single more effective or coherent whole". Coordination, on the other hand, is defined as "the organization of the different elements of a complex body or activity so as to enable them to work together effectively".

As urbanization increased after the Second World War, cities have become denser than ever and freight transportation within the cities has grown enormously. The concept of *City Logistics* (CL) has evolved to solve the problems regarding freight transportation inside the cities. The major distinction between CL activities and those involving FVs is the relative location of the facilities with regard to the cities; CL takes place within cities, while FVs involve logistics activities outside cities. Liu et al. (2013) visualize the dispersion of such villages in France for the last 50 years and tries to explain this contrast using empirical data. Along with the massive developments in the information technologies, Intelligent Transportation Systems (ITS) have been used in logistics activities, starting with the end of the 20^{th} century. ITS aim to benefit from the integration of data and transportation activities. While ITS applications may be involved in FVs as well, it is worth noticing that ITS applications are more human oriented and mainly focus on human movement.

To better understand the significance of freight transportation and the increasing volume of goods distribution, some figures from around the globe are given in Figures 1-3. In different parts of the world, freight transportation volumes are increasing at different rates depending on the size and the nature of the economies. With the shift of economies around the world (especially due to offshore activities), freight transportation has skyrocketed in China, compared to the early years of 1990s. The figure has increased from 3,590 billion ton-kilometers in 1995 to 16,873 billion ton-kilometers in 2013, which corresponds to a nearly 400% increase (National Bureau of Statistics of China 2015). In the US, total freight transportation increased by a smaller amount (12%), from 5,288 billion ton-kilometers in 1995 to 5,899 billion ton-kilometers in 2011 (National Transportation Statistics 2015). Compared to the US, European countries show a more significant

increase in their freight transportation numbers, 2,846 to 3,482 billion ton-kilometers (22%) from 1995 to 2013 (EU Transport in Figures, Statistical Pocketbook 2015).

An important indicator that shows the recent trends in logistics activities is the modal breakdown of freight transport, showing the different transportation modes used for these activities. Even though freight transport modes shifted from road to rail and sea with the increase in containerization, freight transportation by road is still the most dominant form of transportation around the world, except for China and some European countries with very high levels of development in freight infrastructure, such as the Netherlands and Denmark (Schwab et al. 2015). On the other hand, the modal breakdown shows different results for China compared to the remainder of the world; with inland waterway freight transportation having the largest percentage as opposed to the roads or railways.

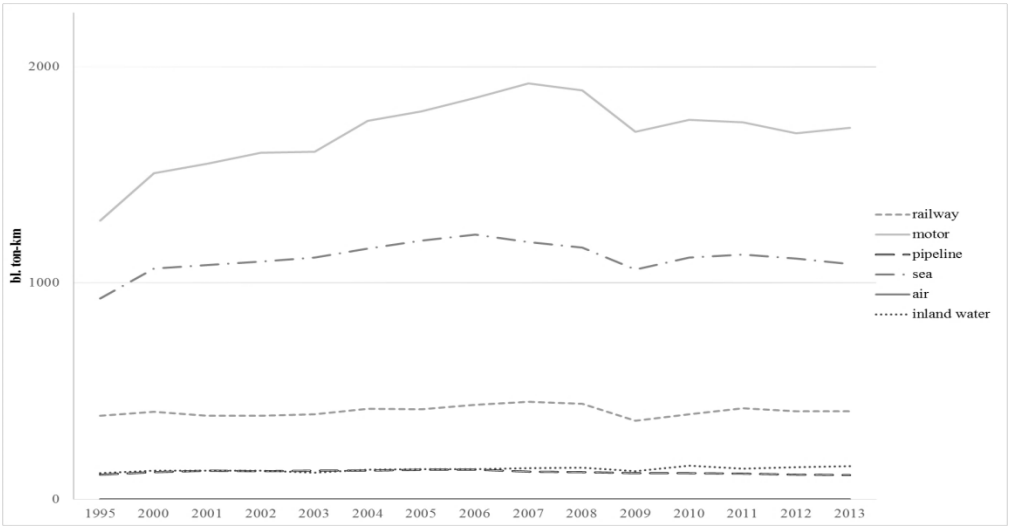

Figure 1. EU-28 performance by mode for freight transport in billion ton-km (EU Transport in Figures, Statistical Pocketbook 2015)

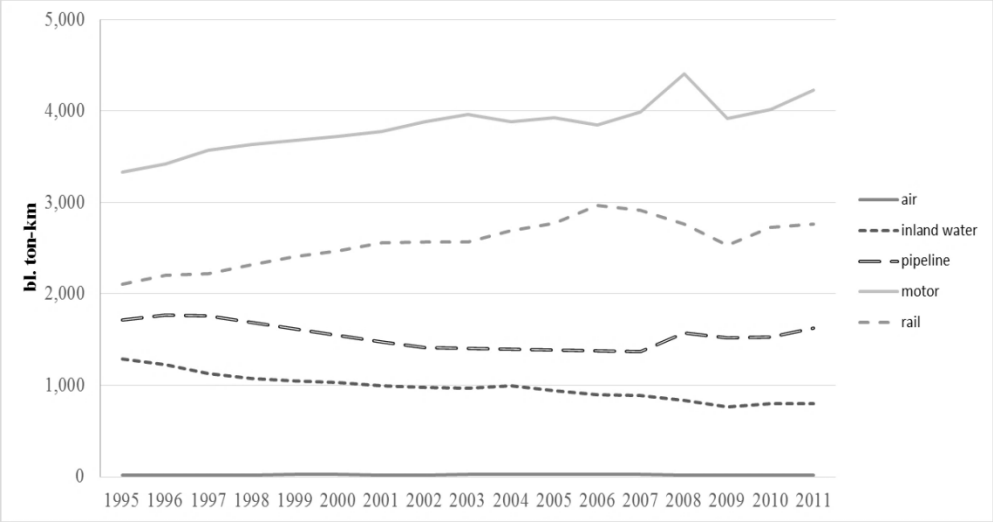

Figure 2. USA performance by mode for freight transport in billion ton-km (National Transportation Statistics 2015)

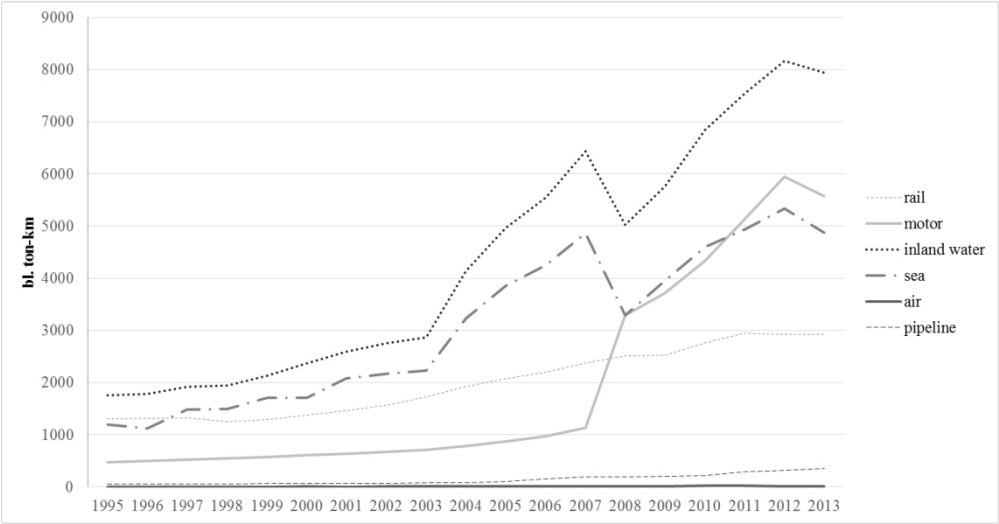

Figure 3. Transportation of goods by different transportation modes in China in billion ton-km (National Bureau of Statistics of China 2015)

For China, as many industries focus on outsourcing their activities in the mainland, the amount of goods flowing through country from and to the international markets is becoming enormous as can be seen from the figures above. Furthermore in the Chinese case, substantial governmental effort is made for development of mainland China through the waterways usage. The idea is to promote

the cities and the regions surrounding the waterways by increasing the economic activities there (China Today 2016).

With the significant increase in freight transportation and its intermodal breakdown, infrastructure and the related facilities must surely be adapted so that they can offer quality service, enabling sustainable businesses and environment while caring for the stakeholders. The idea of FVs comes into picture here, claiming to provide a solution to these requirements.

3. Freight Villages

EUROPLATFORMS, the responsible body in EU on FVs, gives a clear definition of a freight village as "a defined area within which all activities relating to transport, logistics and the distribution of goods, both for national and international transit, are carried out by various operators. These operators can be either owners or tenants of buildings and facilities (warehouses, break-bulk centres, storage areas, offices, car parks, etc.) which have been built there. In addition, in order to comply with free competition rules, a FV must allow access to all companies involved in the activities set out above. A FV must also be equipped with all the public facilities to carry out the above-mentioned operations. If possible, it should also include public services for the staff and equipment of the users. In order to encourage intermodal transport for the handling of goods, a FV must preferably be served by a multiplicity of transport modes" (EUROPLATFORMS 2004).

Unfortunately, there has not been a formal consensus on the nomenclature of these systems (as FVs themselves consist of many different parts working together, in harmony for a purpose). Some of the different names for these systems used in the European, South East Asian and North American countries with high levels of logistics capabilities and high logistics indices, are given in Table 1 (Rimienè et al. 2007, Schwab et al. 2015).

Table 1. Alternative names for FVs

Country	Name
Great Britain & USA	Freight Villages
France	Plate Forme Logistique / Plat Forme Multimodal
Italy	Interporto
Germany	Güterverkehrszentrum
Denmark	Transport Centre
Singapore & China	Logistics Center / Logistics Centre

In this study, the term *freight village* is used in place of all the terms mentioned in Table 1.[2] Although different languages lead to different terms to indicate a Freight Village, it is worthwhile to notice that the phrases are used to describe activities related with goods traffic, modality, and integrality. The frequent usage of the word "center" in the terms is a sign so that these systems are complex facilities where activities related with freight transportation are concentrated. It is worth noting that coordination activities are realized in most logistics operations. However, coordination should not be solely understood as working together. It rather involves acting bodies working together as parts of a system; for a common purpose and for the benefit of all bodies. The interaction of the collaborating bodies is essential in understanding the purpose and behavior of this system. As Wu et al. (2011) also point out, collaboration is a framework of operations and strategies, such as planning, knowledge sharing, knowledge integration, acquisition, cost sharing (e.g., common infrastructure usage, joint marketing), performance reporting, rewards and punishment systems, and vision/mission statements. Jaržemskis (2007) states that interacting bodies in this way form a synergy that has potential benefits.

As purposeful systems, decision making for the management of FVs needs to follow a well-structured vision, which should be in line with the purpose they have evolved to fulfill. Along with increasing the efficiency of the activities related with freight transportation, the urge for building FVs results from the need to obtain increased effectiveness from the supply chain. The purpose for the development of FVs in today's world differs throughout the globe, with each different

[2] The alternative terms currently in use such as Logistics Center (Logistics Centre), Distribution Center, Distriport, Distripark and Dryport can be misleading, as any facility conducting logistics activities (such as planning, warehousing, and distribution) is a "Logistics Center". On the other hand, a FV involves coordination and collaboration among different commercial bodies.

geography having its own needs to be addressed. For developing countries, this need is much more related to market penetration possibilities and increased competitiveness (in addition to sustaining social equity through regional development), while for a developed country (in addition to all the aforementioned factors) sustainability is one of the major principles to consider.

In the current study, achieving sustainability has been related with effectiveness. Besides, we take into account the fact that "inclusion and equity are indispensable requirements for sustainable development" (Clark, 2012). We provide a more detailed account of how sustainability and equity are perceived in the scope of FVs in Section 5.

FVs offer logistics services by means of their technological and organizational resources. In addition to supplying the necessary information and performing value-added activities, FVs also cover all activities related with logistics and transportation both in the regional and international markets. However, certain challenges arise in carrying out these activities. Higgins et al. (2011) point out to these shortcomings by underlining the coordination difficulties between different levels of government and conflicting political interests. There can be risks of oversupply as every jurisdiction strives to pursue the latest trend. On the private sector side, there is the fact that modern day supply chains are mostly vertically oriented, whereas the FV concept is inherently horizontal and, in its ideal form, at least partially depends on the cooperation among firms. In many FVs, firms have been observed to operate completely independently of others in the development. Concerns about cooperating for competitive reasons and a dependence on government subsidies have also led to difficulties in the urban consolidation/distribution potential of FVs.

Structural information available in the literature regarding some of the existing FVs can be found in Table 8 in the Appendix. The main services offered by FVs can be summarized as follows (Boile et al. 2008):

1. **Broad Functions:** Warehousing, cargo divisioning, international cargo transfer, distribution services, Industry integration.
2. **Intermodal Facilities:** Transshipment/transloading facilities, airports, seaports, rail links to ports and/or airports.
3. **Traditional Logistics Services:** Container handling, storaging, warehouse leasing.

4. **Contemporary Logistics Services:** Transshipment, consolidation and deconsolidation for local distribution or long distance shipping, horizontal integration between participating companies.
5. **Value-Added Logistics Services:** Free trade zone, barcoding, palletizing, performance analysis, packaging/repackaging, labelling, quality assurance operations, supply chain management consulting, commissioning, call center management, temperature controlled environments, hazardous material services.
6. **Additional Features:** Repair garages, R&D activities, hospitals, schools, post offices, weigh bridges, hotels, office spaces, hygiene facilities, restaurants, conference halls).

The amount of freight transported thorugh several FVs (located in Europe) and the percentage of total traffic in the country they handle can be seen in Table 2 (since data is not available for TEU units and Road/Rail operations, the related percentages are not shown).

Table 2. Example FVs, capabilities, and estimated traffic flows (Boile et al. 2008).

Country	FV	Road	Rail	Air	Water	Road/Rail Traffic	Rail Traffic est. (1,000 T)	Road Traffic est. (1,000 T)
France	Roissy-SOGARIS	X	X		(X)	25	-	2,500 (0.13%)***
Hungary	Budapest Intermodal Logistics Centre	X	X	(X)	(X)	87 (2005)	-	-
Italy	Interporto Bologna	X	X			3,906 (2002)	1,777 (2003) (2.1%)	2,250 (2003) (0.18%)
	Interporto Novara	X	X		(X)	-	-	436 (2005)
	Interporto Parma	X	X	(X)	(X)	5,000 (2006)	1,600 (2006) (1.56%)	3,500 (2003) (0.28%)
	Interporto Rivalta Scrivia	X	X	(X)		1,500 (2006)	500 (2003) (0.49%)	1,000 (0.08%)
	Interporto Torino	X	X			-	-	3,000 (2003) (0.24%)
	Interporto Quadrante Europa	X	X		(X)	26,000 (2003)	6,000 (2003) (7.18%)	20,000 (2003) (1.6%)
	Interporto Verona	X	X			26,000 (2003)	6,000 (2003) (718%)	20,000 (2003) (1.6%)
Portugal	Terminal Multimodal Do Vale Do Tejo S.A.	X	X	(X)		1 (2003)	-	-
Spain	Bilkakobo-Aparcabisa	X	X		(X)	-	-	425 (2003) (0.02%)
	Centro de Transportes de Irun	X	(X)		(X)	-	-	2,800 (2003) (0.15%)

***** T refers to Tons, (X) means there exists a corresponding facility in the vicinity.
** est.: estimation
***The percentage of total traffic in the country

Keeping the main services offered by FVs in mind, the sample list in Table 2 gives an idea about the potential capability of such FVs in terms of freight distribution volumes and offering intermodality. However, because of lack of data, drawing exact conclusions about the exact capabilities of FVs from these figures is not possible without site surveys to reach data, particularly in countries that lack well-developed institutions. Nevertheless, when the capabilities of the FVs are investigated, it is clear that these systems are crucial elements in overall supply chain effectiveness. As there are global concerns regarding the sustainability of activities in all industries, it appears that without the coordination and collaboration supported by FVs, sustainable synergy and data management needed for conducting business become impossible. One simple explanation for this is that although there has been a common understanding on the value of information sharing and horizontal integration activities, i.e., the companies becoming aware of phenomena such as the bullwhip effect, it is not always possible to realize the integration activities as expected. Another impact of FVs with coordination and inter-modality activities is the reduction in overall haul transportation distances and the decrease in emissions (Hanaoka et al. 2011; Lättilä et al. 2013).

In search of more profound understanding of how the concept of FV is perceived in various parts of the world and over time, as well as how it relates to the overall logistics system, and sustainability and societal equity, we present a systematic literature review in the following section.

4. A Systematic Review of the Literature on FVs

This section presents a systematic literature review on academic studies regarding FVs. The review is performed to assess the scope of the academic studies on FVs by focusing on the evolution of these studies over time, the countries or regions with which they are related, and their subject areas. We also aim to assess the extent at which the sustainability and social equity issues are incorporated into these studies, and point to potential research directions in these areas. We first provide the details of the method used to search for relevant articles. The remainder of the section focuses on the results of the review.

4.1 Overall Method

The systematic search method in this study follows that used by Kilubi (2016) and Gligor et al. (2012), who concentrate on systematic reviews of strategic supply chain management. In the following sections, we explain the search steps, evaluation of this research, and the interpretations of the findings.

4.2 Search Query

The search mainly focuses on two main academic databases, namely Scopus and ISI's Web of Knowledge. The starting keywords of the search included the two most widely-used phrases for the subject: "Freight Villages" and "Logistics Centers". The search looked for these phrases (with quotation marks in order to avoid irrelevant articles), and yielded 58 distinct articles from aforementioned web sources. Later, in order not to miss any previously published work on the issue, an additional search was conducted using the 20 relevant keywords arising from different definitions of FVs. These keywords are provided in Table 3.

Table 3. Keywords used in the search

Distripark**	Distriport***	Freight Terminal**	Integrated Freight Center
Intermodal Freight Center^{+++}	Platform Freight Terminal*	Transport Terminal**	Freight Center
Freight Centre	Freight Logistics Centre^{++}	Freight Village*	Inland Port****
Intermodal Terminal^{+}	Logistics Center*	Logistics Centre	Logistics Park*
Logistics Platform	Merchandise Integrated Center***	Transport Center	Transport Centre*

*EUROPLATFORMS, **Rimiene et al. (2007), ***Lima et al. (2010), $^{+}$Ballis (2005), $^{++}$Kapros et al. (2005), $^{+++}$Kayikci (2010) states that the above-mentioned keywords can be used interchangeably with FVs, so they had been included in the search query.

The query (which required minor format changes in different databases) was as follows: "keyword AND language=English AND ('source title includes transportation' OR source title=logistics OR 'source title includes network' OR 'source title includes freight')". The source titles were limited on purpose for a more efficient search, since the resulting sources with this search would be more specific on the concept. In order not to miss the studies published in other sources, the source filter was omitted for a second search run. With this set of keywords, and two search runs (in separate databases), a total number of 98 distinct articles were obtained after removing the duplicates in different search databases. A second search was made, this time combining the keywords that were used in this search with the new keywords "sustainability", "green" and "equity". The new search

queries were as follows: “one of the new keys AND one of the previous keywords for FVs AND Language=English”. To reach a controllable amount of studies, source type was specifically set to “article” (the first run also included conference papers, declarations, working papers, and books). As a result, no additional articles came up that were distinct from the ones that were found in the first search run. To obtain an overall understanding of the trends and approaches in the literature, the quotation marks were erased and a quick search among the 154 articles that were obtained as a result of the search for the query “freight AND sustainability” was made. Again, no new articles were added to the previously found articles and five articles overlapped. The main trends found to be related with the current study were methods for decreasing emissions, noise and vibration, increasing societal equity through increase in investments to a region and the resulting infrastructure development. In order not to lose the scope on FVs, the second search results are not given in this study.

4.3 Results of the Systematic Literature Review

Following the methods by Dickersin et al. (1994), Denyer and Tranfield (2003) and Denyer et al. (2009) in their systematic literature reviews, a further elimination is made to focus solely on studies leading to relevant questions on FVs and an observation of the gaps in the literature. Among the 98 original articles, 24 focus on a generic modeling or solution technique, rather than the concept of freight villages with concerns about sustainability and equity, thereby lacking novelty in terms of contribution to the FV literature. For example, Aksoy et al. (2015) use a mixed integer model to decide on the location of FVs of Turkish State Railways. However this model aims to the increase in efficiency in goods flow without regard to the structure of the FV. As another example, Bottero et al. (2013) consider the monitoring of the traffic in a FV with wireless sensors by focusing only on sensor sensitivity. Another example is Yang et al. (2007), which focuses mostly on locating a FV and its corresponding mathematical model, with no emphasis on the particular role of the FV in the system.

Table 4. Distribution of articles through the years

Years	Number of Articles	%
After 2013	36	51
2008-2012	16	23
2003-2007	13	18
1998-2002	6	8
Total	71	100

Three papers out of the remaining 74 are classified as “auxiliary”, because their focus is not on directly contributing to the aim of this study. However, such studies are helpful in understanding how researchers are looking into the field from different perspectives. Of these, Ross et al. (2004) focus on how the efficiency of the distribution systems change with the increase in size, King et al. (2014) discuss the possibility of promoting FV usage with road pricing policies, and Ishfag et al. (2011) describe the network structure of intermodal logistic networks. The remaining 71 articles were analyzed in detail to come up with new questions, research directions, and conclusions.

4.3.1 Classification based on time

As Table 4 clearly demonstrates, a look into the yearly distribution of articles shows the emphasis on the field has increased after 2008. Of the first two articles published in 1999, Wiegmans et al. (1999) analyze possible terminal market, services, size of potential terminals, and buyers while Tsamboulas et al. (1999) collect data via mail and conducts statistical analysis on the appraisal on investments in FVs.

Because the concept of logistics itself has increasingly involved a holistic view starting from the 1990s, and due to the evolution and continuous change of the activities in the same period, there is an increasing trend regarding the studies on FVs over the years as well. More than half of the articles have been published after year 2012, and 74% have been published after 2008. Table 4 gives the distribution of articles over the years.

Table 5. Number of articles with respect to different economies (Schwab et al. 2015)

Economy (gross national income per capita**)**	**Number of Articles**	**%**
High-income economies ($12,736 or more)	34	64
Upper-middle-income economies ($4,126 to $12,735)	17	32
Lower-middle-income economies ($1,046 to $4,125)	2	4

4.3.2 Classification in terms of country and economy

53 (75%) of the 71 articles include information about a specific country that the data is collected and/or the study was conducted in. Numbers of articles with respect to different countries of focus are presented in Table 5. The remaining 18 articles provide generic information about the FVs. China and Greece lead the number of articles published with a specific country of interest (each with 6 papers). After China and Greece, Germany and Sweden follow with five articles. China, Greece, Germany and Sweden, along with Turkey, Lithuania, the USA, Italy, Finland, and Hungary constitute the 80% of the articles with specific country information. In total, 22 different countries were present in those 53 papers, namely (in decreasing number of papers) China, Greece, Germany, Sweden, Turkey, Lithuania, USA, Italy, Finland, Hungary, Brazil, Spain, Poland, India, Laos, Serbia, Iran, Croatia, Mexico, Kazakhstan, the Netherlands, and Japan. These numbers point to the fact that the concept of FV has been appreciated nearly all around the world in different economies.

As mentioned before, FVs have the potential to answer different questions in different geographies. However, the amount of investment needed and the infrastructure costs may be challenging for a country with a lower-middle-income economy. The distribution of the number of articles with respect to economies shows that the majority of the articles (96%) focus on high-income or upper-middle-income economies, although one must of keep in mind that the economy classification used here does not include an equal number of countries. Again, there is lack of data in the literature for the FV applications in lower-middle-income economies and the amount of overall freight transportation activities are lower for lower-middle-income economies compared to high-income and upper-middle-income economies. These two factors clearly affect the number of articles focusing on lower-middle-income economies.

4.3.3 Classification based on scope

The first step of the classification of articles is based on scope, which is summarized in Figure 4. 12 articles (17%) have a more general scope with a conceptual approach, while the remaining 59 are based on case studies either on the country level (i.e., looking at the overall dynamics for a specific country) or at the individual level (i.e., assessing individual FVs in the same country), and/or FVs in different countries/continents. We further classify these articles by their contribution to the literature; either by assessing a dimension(s) or by investigation and/or proposing design approaches.

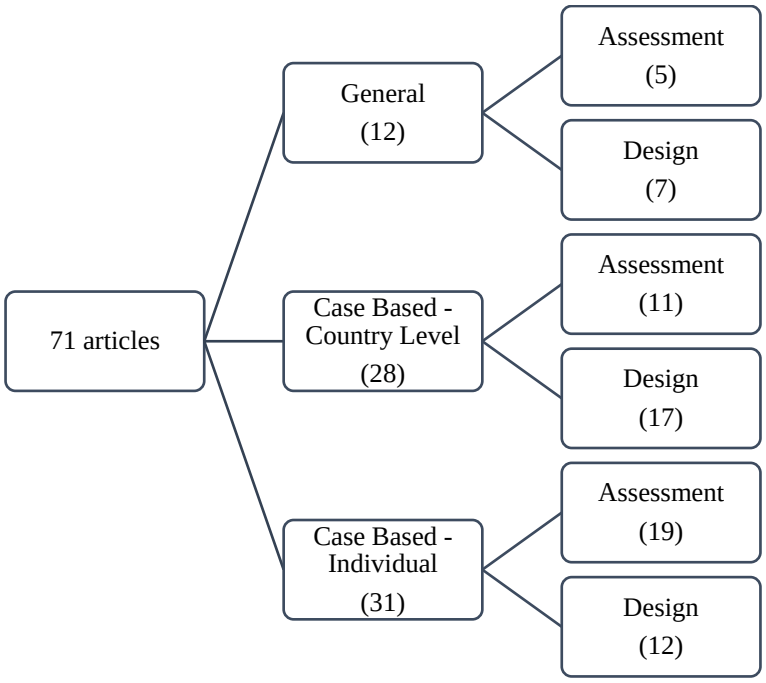

Figure 4. Articles with respect to their scope

A deeper look into the 71 articles mentioned above shows that, in 49 (69%) of these articles, the focus is on a specific dimension, i.e., the characteristic of the article is reflected on that dimension only. The scope, category, and the dimension information of these 71 articles are presented in Table 8 in the Appendix. “Other” is used as a separate dimension, as there exists more than one distinct dimension for 22 of the articles, the design or the assessment methods cover more than one aspect. For these 22 articles, Table 10 in the Appendix gives details on the work carried out, presenting the different dimensions of the study.

4.3.4 Interpretation of results

Clearly, the articles with the dimensions “environmental impact”, “regional development”, and “efficiency” (in terms of less negative environmental effect) add value to the literature in terms of sustainability and social equity. Altuntas et al. (2013) design green buying criteria for FVs. The greening effects are crucial for the environment, but a pitfall for the study is the fact that most of the time the choice of a FV will depend on the location of the facility and the lack of FVs in a region will make it impossible to impose such green buying criteria. Hanaoka et al. (2011) and Lättilä et al. (2013) consider the impact of coordination on the reduction in overall haul transportation distances and the decrease in emissions. Haralanbides et al. (2012) give a promising “eco-DEA” model to use in the assessment; although the article is considering the dry ports in India, the proposed model can be generalized easily. Monios (2015) and Vrochidis (2013) point out the increase in employment numbers with the establishment of FVs. However, there are many factors affecting the national economy. Hence, the correlation between the FVs and the employment figures is not reliable. Sainz et al. (2013), on the other hand, provide a thorough assessment of the overall development of the region with the FVs (especially in terms of infrastructure).

With the articles presented in Table 10 in the Appendix, one can infer a holistic view into FVs. For example, Bodaubayeva (2015) investigates the effects of FVs in Kazakhstan in terms of impact on regional development and gives ideas about the size and potential location of such facilities. The FV-2000 report, created by the EU Commission in year 2000, is one such document giving guidelines about all the design aspects of a system.

The articles in Table 10 provide significant contributions to the literature because the authors cover multiple aspects of FVs rather than mainly focusing on a single aspect. Since these are purposeful systems, an overall view is essential to understand the place of the FVs in logistics and supply chain networks. Location, size, and governance are most popular dimensions between the articles in Table 10. Locating a FV and planning its capacity are no surprise popular dimensions for studies but the emphasis in governance, points out the distinction of a FV from a conventional distribution center. This is because the infrastructure to form synergy and interaction of the bodies inside the FV is especially important.

By category, design papers are relatively more in number than assessment papers, and are populated under case-based country level articles. This underlines the need for performance metrics for measuring FVs' efficiency and effectiveness. In the articles presented in Table 10 in the Appendix, there is no article that focuses on assessment on intercontinental basis, i.e., presenting different characteristics of FVs located in different geographies and comparing their efficiency and effectiveness. How effective FVs really are in these aspects will be discussed in Section 5.

5. Impact of Freight Villages on Sustainability and Equity

Recent research shows that humankind's effect on the environment has come to an irreversible stage. Unlike the past few decades, when it was merely a visionary move to care for the environment, with the beginning of 21st century, these effects on the environment have become impossible to ignore. In this atmosphere, our age has given birth to the notion of sustainability, obliging us to think about the future more while taking an action. Sustainability in a broader sense is a framework that stipulates that available resources of today directly and profoundly affect those of tomorrow. The United Nations gives a comprehensive definition of sustainable development as one "that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNCED 1992). Hence, it pushes the acting bodies to think and take actions if necessary to change their life. The focus on sustainability has been particularly increasing since the start of the 1990s (Olazabal et al. 2015). In fact, many countries have been implementing policies for their economies to adapt to this philosophy. Logistics activities account for most of the (nearly all negative) effects against the environment (such as extreme weather) mainly due to emissions (Jaroszweski 2012). Hence, a sustainable approach is essential. Prause (2014) gives three different perspectives on sustainability as economic efficiency, environmental efficiency, and social efficiency. Lozano (2008) visualizes these three dimensions and discusses how their integration changes with different perspectives.

Particularly when logistics is provided as a public service, establishing social equity arises as an additional concern, along with the efficiency and effectiveness of operations. Here, the main aim is to establish a more equitable distribution of income over various geographical regions by means of logistical activities. However, a formal definition of societal equity and its relevant measures have been the subject of extensive debate. Over history, three schools of equity have been

dominant: (1) the Aristotelian idea of equity based on proportional satisfaction of needs (Bertsimas et al. 2011), (2) classical utilitarianism, where the aim is to improve the well-being of the whole society rather than individual people or regions (Marsh and Schilling 1994), and (3) the Rawlsian school of difference-based equity, in which the decision makers strive to improve the well-being of the worst-off beneficiaries of the services as much as possible (Yang et al. 2015). Given the variety of views on equity, defining appropriate measures is challenging, and generally case-specific. Modern applications of social equity are based on combinations of the measures arising from the Aristotelian and Rawlsian schools. In general, the aim to satisfy such measures usually results in a trade-off between equity and efficiency of operations, and thus decision makers usually make use of compromise measures taking both aspects into account. Another important challenge in accounting for societal equity is that equity-based models of logistics problems tend to be significantly computationally challenging as opposed to their efficiency-based counterparts.

As can be understood from the previous work, a FV is a purposeful system. The main motivation behind the implementation of these systems is the belief that they provide more effective ways of conducting logistics activities; adjusting to the needs of the environment surrounding them and the stakeholders they are in relation with. According to Boiel et al. (2008), example purposes for FVs are environmental sustainability and economic development. Regmi et al. (2013) also point to environmental sustainability, Higgins et al. (2011) mention reduction in emissions, increase in investments and employment, as well as environmental sustainability. Some fundamental findings from the literature, which are summarized in Table 6 also justify this. It is clear from these findings that FVs are designed to contribute to the logistics and supply chain networks along in many different aspects, but most importantly in terms of sustainability. The selected articles in Table 6 contribute substantially in terms of understanding the structure of FVs and the capabilities of a FV in achieving (more) sustainable logistics and supply chains. We question the literature on FVs impacts on sustainability based on two perspectives of sustainability, namely environmental impact and social equity. The economical perspective is not taken as a concern in this study, since the benefits FVs on scope and the scale of business activities are already promising, and for any commercial firm to enter such a business cooperation with other firms, some measure of risk and/or cost minimization must be satisfied.

Table 6. Findings on FVs from selected articles

Author / year	Title	Findings
Yang et al. (2015)	Efficiency analysis of European Freight Villages: three peers for benchmarking	FVs are not just logistical interconnection points within a logistics network but they are also business generators.
Bodaubayeva (2015)	Formation of Industrial and Logistic Parks in Kazakhstan	FVs are seen as regional growth points; supporting cost reduction and competitive advantage through acces to infrastructure and communications, the combination of all modes of transport and the unifonned logistics management of service providers.
Calis et al. (2014)	Historical Development of Worldwide Freight Villages and Freight Villages in Turkey	FVs aim at reducing logistics costs, decreasing transportation and transfer times, decreasing joint expenditures by creating synergy among persons and institutions providing logistics services, increasing the quality of service, strengthening the procurement chain of the sector to which the services are supplied and attainment of increase of added value, decreasing the environmental effect and carbon emissions, decreasing traffic accidents and congestions, make direct contribution to the optimization of the procurement change as a result of arrangement of traffic load of roads.
Wu et al. (2013)	Converting Knowledge into Sustainability Performance of Freight Villages.	FVs have less negative environmental impacts compared to classical way of conducting logistics activities. They are a cluster of quality industrial-intermodal-distribution-logistics buildings located within a secure perimeter where a range of support services are provided by every user, enabling a high degree of accessibility and transfers freight from one mode to another.
Wu et al. (2011)	Knowledge-based Stakeholder Collaboration for Sustainable Development of Freight Villages	FVs offer common services to various transport and logistics companies located within its site, as well as to other external users. A FV is a typical cluster of various firms relating to logistics activities, which rapidly extend their scope and size into worldwide global markets, as well as interact closely with their surrounding citizens and nature environment.
Winkler et al. (2011)	Management of freight villages: findings from an exploratory study in Germany	Logistical interconnection points; that function as an interface between local and long-distance goods, FVs can lead to the rationalisation of transport and logistical services, inducing cost savings along the entire logistics chain.
Lima Jr et al. (2010)	Sustainable Logistics Platform in a Regional Brazilian Airport	A FV is strategically situated site, encompassing several logistics activities, with a large transportation infrastructure that provides competitive advantages and enhances the logistics activities of the participants engaged in the companies business also generating significant number of jobs. This infrastructure is a modernalternative to solve the problems caused by the increased flow of vehicles circulating in a city because of the intensified demand of goods distribution. FVs involve alliances between organizations responsible for transport services, warehousing and distribution that can generate significant reductions in urban traffic, environmental pollution and social problems
Hamzeh et al. (2007)	Logistics Centers to Support Project-Based Production in the Construction Industry	A FV is focal point for material flow streams in a logistics chain. It thereby provides access to different shipmen modes, performs broad logistic functions, serves a wide range of users, presents information technology solutions, and offers value added services. The existence of a FV is a stimulus to generate business; acting as an impulse for business and economic development.
Ballis et al. (2007)	Freight village design using the multicriteria method PROMETHEE	A FV located in the vicinity of a large city may provide an efficient solution to urban freight transport problems including traffic congestion, regional competitiveness, and quality of life. FVs evolve alliances among the entities responsible for the transport, storage and distribution services, which can generate significant reduction in the number of trucks vehicle-kilometers
Meidute (2005)	Comparative analysis of the definitions of logistics centres	This article is the contains the only single work on the linguistic backround of the definitions and usage of these definitions.
Ballis (2005)	Freight Villages: Warehouse design and rail link aspects	A FV is a defined are organized for carrying out all activities related to transport, logistics and distribution for both national and international transit.
Kapros et al. (2005)	Multicriteria Approach to the Evaluation of Intermodal Freight Villages	FVs are specialized zones offering space and common services to transport operators for the public good.

Table 7: Articles focusing on sustainability and social equity

Sustainability Perspective	Title and reference	Findings
Decrease in negative environmental impact resulting from emissions	Promoting intermodal freight transport through the development of dry ports in Asia: An environmental perspective, Hanaoka et al., 2015.	Railway connections to dry ports can reduce freight emissions of CO_2 and local air pollution through a modal shift that reduces the number of long-haul trucks plying on roads. Some cases demonstrate this potential. The current congestion and pollution at are isolated cases that will be eased once the capacity of the inland container depots is expanded and the share of rail freight is increased. Investment in railway infrastructure/dry ports can encourage modal shifts to greener modes of transport.
	Greening logistics centers: The evolution of Industrial buying criteria towards green, Altuntaş et al., 2013.	Adopting green buying criteria to FVs service buying criteria.
	Hinterland operations of sea ports do matter: Dry port usage effects on transportation costs and CO2 emissions, Lättilä et al., 2013.	Mathematical models and simulation studies are used to show that the estimated CO_2 emissions can decrease with increased Dry port usage (the usage includes activities that a FV is capable of such as increased intermodal transportation and intermodal shift)
Aiding regional development	Intermodal transport as a regional development strategy: The case of Italian freight villages, Monios, 2015.	The national plan for FVs does not produce such coordination across the network, manifesting in conflicts between spending on old and new sites. The major finding from the research is a misalignment between the national and regional scales, as funding based on national policy does not align with port and FV planning strategies developed at the regional level.
	Logistics centres as economic drivers of their regions, Vrochidis, 2013.	Five example FVs have been selected for demonstration as case studies to show the impact of FVs on regional development. There is actually new number of jobs directly and indirectly related to transport and logistics sector. However it must be noted that, during the time period of the study (2003-2010) the freight traffic and urbanisation numbers also increased in the case cities hence, to draw exact conclusions is hard.
	The economic impact of logistics infrastructure: the case of PLAZA – the Zaragoza Logistics Platform, Sainz et al., 2013.	The total impact of PLAZA on the Autonomous Region of Aragon is calculated by a Leontief function; adding the direct, indirect, and induced impacts, estimating the creation of 1.88% of total jobs in the area.

Colicchia et al. (2013) highlight the work in the literature questioning the effect of logistics activities on sustainability and how collaboration can be benefited. In terms of obtaining collaboration and coordination, FVs are definitely promising systems resulting from their structures. Nevertheless, when the articles in the mentioned literature search are analyzed, few major keywords have been identified that would point to the dimension of the study is on effects of FV on sustainability. It is surprising that only six of the articles (<10%) were aimed at focusing on sustainability from the sustainability and regional development perspective, which can be seen in Table 7. From their sustainability perspectives the articles are distinguished into two groups. From the sustainability perspective, Hanaoka et al. (2015) point out the importance of railways in freight transportation and the possible reduction in CO2 emissions by shifting to railways. Lättilä et al. (2013) also have similar findings; reduction in CO2 emission by increased intermodality and dryport usage. Altuntaş et al. (2013) declare green buying criteria, yet it is important to keep in mind that, for competitiveness and capacity limitations, generally buying criteria would be solely be the location of a FV, rather the green criteria, which promise to enable environmental sustainability. From the social equity perspective, Vrochidis (2013) and Sainz et al. (2013) relate

FVs presence and the increase in employment numbers. FVs seem to fulfill being a business generator in the cases presented. However one must treat the correlation between FVs and the increased employment numbers with caution since it is not possible to see the sole effect of FVs presence on the number of jobs created. The increase in freight capacity itself may very well increase the employment level. Lastly Monios (2015) tries to come up with answers for aligning national and regional goals on the strategic planning of FVs.

In addition to these findings, no formal measures have been devised to assess the impact of FVs on social equity, nor have any existing ones been used for that purpose. Here, the effect of FVs on sustainability and equity has been observed from the systematic literature review. This bears the question of whether the real impact of these systems on environmental sustainability and regional development are overrated, or because of the lack of data that the true concepts regarding sustainability have not yet been considered. If so, the available information is not sufficient to justify the significance of the positive effect of these systems. Even the usage of the words "equity" and "sustainability" is a slight indication. 9 out of 71 (13%) articles contains the word "equity"; the word itself appears 17 times at total. 24 out of 71 (34%) articles contain the word "sustainability"; the word appears 226 times. However, 108 of these 226 (48%) instances appear in Wu et al. (2003).

Even though the studies include case-based work, to assess the true impact of FV without noise is not possible from our literature review. Hence, based solely on these results, FVs seem to fail at filling the needs they were evolved for as complex systems. Another way of looking at this issue is that, it is possible the researchers are focusing a lot on the operational side of the FVs and missing the big picture since, right from the initialization step, these systems are the products of nothing but strategic decisions. As mentioned in Section 3, social equity is an essential part of sustainability. It is crucial to understand that for achieving sustainability (and necessarily social equity), paradigms related with operational efficiency such as cost minimization and capacity must be abandoned. Rather, effective systems must be desired.

6. Conclusions and Potential Research Directions

It seems that there is a research gap in the related literature due to lack of data and absence of research questions related with sustainability and equity in the context of FVs. With the output of

the systematic literature review explained in Section 4, this fact becomes clear and leads to a number of research directions. Future work must focus on more field studies in the FV area. There is a question of data integrity and inconsistency for case-based studies. Hence, more empirical studies are needed. For a potential researcher, it is also important to keep in mind that part of the publications on transport and logistics are from non-academic resources. Therefore, both the government and the private sources should also be revised prior to such an empirical study. Another potential area for improvement is the linguistic background of the FVs. The work by Meidutė (2005) is the only study focusing on the usage of the terms. In accordance with that, a former historical development scheme would be extremely beneficial for researchers working on the topic to understand clearly how different economies respond to such a change and how they integrate these systems with their current infrastructure, as also investigated by Rimienė et al. (2007). Furthermore, a GIS representation on the locations is so far available only for individual countries; an overall look and spatial analysis of intra and inter-continental freight transportation and their relation with FVs would give a lot of insight about the role of FVs in supply chains.

Although there are many review papers about logistics activities and supply chain management, our survey found no review papers on FVs. While the work by Bookbinder (2013) seems to be relevant, it collects several global logistics articles and lacks a review focusing on FVs. A comprehensive review on this subject would be very beneficial, since it would cover many aspects in literature.

Physical Internet (PI) applications might come relevant to a researcher in this field. PI applications also consider different dimensions of sustainability (i.e., economic, social, and environmental). It is worth noticing that in contrast with the centralization focus of a FV, PI applications tend to decentralize freight transportation. For social sustainability, it is shown that PI facilities significantly decrease the effects of shift work and lead to a decrease in milages (Fazili et al. 2017). However, creating jobs and/or local development are not prominent features. Nevertheless, as Montreuil (2011) states, PI is visionary and open to development and enhancement, i.e. in the near future, it may evolve to fulfill different needs.

Currently, the literature also lacks clearly stated performance indicators for FVs related with sustainability and social equity. Even for measures that are more tangible (i.e., how to measure how green a FV is), there is still little academic work.

With the available work in the literature on FVs and their impact on sustainability (decreasing negative environmental impacts and increasing social welfare) in specific, it is not possible to justify the potential of FVs and their promising positive impacts on sustainability such as decreasing greenhouse gas emissions, CO_2 reduction, etc., and functioning as a business generator in the related region they operate. However, it is also crucial to keep in mind that, although the current study cannot justify the potential benefits of these systems on sustainability, with the inclusion of governmental institutions especially in terms of supporting reliable data, one can desire more clear conclusions. The authors strongly believe that it is not logical or realistic for such a system to operate or to be initialized in a, say, European country where the effect of organizations on the environment is closely monitored in detail. In addition, focusing again on the European case, due to the lack of land, such a brown field structure cannot survive solely with the benefit of economies of scale and/or economies of scope.

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APPENDIX

Table 8: Current FVs throughout the world with their properties

Country		General Characteristics			Transportation Modes†			
		Transport Size (Acres)	Employees	& Logistic Firms	Road	Rail	Air	Water
Asia								
China	Shenzhen Pinghu Logistics[1]	4,015	-	-	X	X	X	(X)
	Huaihai Integrated Logistics Park[1]	890	-	-	X	(X)		
	Shanghai North-West ILP[1]	4,653	-	-	X	X		(X)
Korea	Busan New Port Distripark[1]	758	-	-17	X	X	X	(X)
	Gamcheon Distripark[1]	-	-	-	X	X	X	(X)
	Gwangyang Port Distripark[1]	215	-	23	X	X	X	
Taiwan	Far Glory FTZ[1]	111	25,000	-	X	X	X	
	Taisugar Logistics Park[1]	21	-	-	X		X	(X)
Europe								
Denmark	HTC Hoeje Taastrup Transport Centre[1]	371	-	3	X	X		
	NTC Nordic Transport Centre[1]	228	-	15	X	X	X	
	Skandinavisk Transport Centre[1]	321	-	-	X	X	(X)	(X)
	Taulov Transport Centre[1]	519	-	14	X	X	(X)	
France	Roissy-SOGARIS[1,2]	133	2,500	100	X	X		(X)
	Eurocentre Toulouse (Under Development)[2]	740	-	-	X	X		(X)
Germany	GVZ Bremen[1,2]	895	8,000	150	X	X	X	(X)
	GVZ Dresden[1]	61	410	4	X	X	X	(X)
	GVZ Entwicklungsgesellschaft Bremen MBH[1]	524	3,000	-	X	X	(X)	(X)
	GVZ Freienbrink[4]	321	-	-	X	X		
	GVZ GroBbeeren[4]	759	-	-	X	X		
	GVZ Hamburg[1]	138	450	6	X	X	X	(X)
	GVZ Kiel[1]	667	-	-	X	X	X	(X)
	GVZ Nuremberg[1]	833	5,500	260	X	X	X	(X)
	GVZ Osnabruck[1]	114	-	-	X	X	X	(X)
	GVZ Rostock[1]	373	-	-	X	X	(X)	(X)
	GVZ Wustermark[4]	520	-	-	X			
Hungary	Budapest Intermodal Logistics Centre[1]	247	-	-	X	X	(X)	(X)
Italy	Interporto Bologna[1]	1,055	1,500	81	X	X		
	Interporto Novara[1]	207	50	-	X	X		(X)
	Interporto Padova[1]	3,212	1,200	80	X	X		
	Interporto Parma[1]	618	1,300	60	X	X	(X)	(X)
	Interporto Rivalta Scrivia[1]	556	490	40	X	X	(X)	
	Interporto Rovigo[1]	395	30	4	X	X	X	
	Interporto Torino[1]	889	3,000	200	X	X		
	Interporto Quadrante Europa[1]	618	1,800	110	X	X		(X)
	Interporto Venezia[1]	59	250	-	X	X	X	

	Interporto Verona	605	1,800	110	X	X		
Portugal	Terminal Multimodal Do Vale Do Tejo S.A.[1]	548	22	-	X	X	(X)	
Spain	Bilkakobo-Aparcabisa[1]	49	800	40	X	X		(X)
	Centro de Transportes Aduana de Burgos[1]	40	-	17	X	X		(X)
	Centro de Transportes de Coslada[1]	247	-	15	X	X		(X)
	Centro de Transportes de Irun[1]	99	2,100	107	X	(X)		(X)
	Centro de Transportes de Madrid[1]	84	8,000	150	X	(X)		(X)
	Centro di Transporte de Vitoria[1]	268	-	20	X	X		(X)
	ZAL Port de Barcelona[1,2]	177	-	17	X	X	(X)	(X)
	Zona Franca de Barcelona[1]	130	-	7	X	(X)	(X)	(X)
	ZAL Gran Europa[1]	237	1,000	100	X	X		(X)
	Ciudad del Transporte de Pamplona[1]	150	1,000	50	X	X		(X)
United Kingdom	DIRFT Logistics Park[1]	498	-	-	X	X	(X)	
	Keypoint: Swindon's Premier Logistics Park[1]	-	-	-	X	X		
	Kingmoor Park[1]	400	-	100	X	X		
	Wakefield Europort[1]	220	-	16	X	X		
North America								
Canada	CentrePort Canada (Under Development)	20,000	-	-	X	X	(X)	X
Mexico	ADNplus Industrial Multiport (Cancelled)[5]	1,100	-	-	X	X		X
United States	AllianceTexas[1,3]	17,000	28,000	170	X	X		X
	Global TransPark[3]	15,700	-		X			X
	Greater Columbus Inland Port / Rickenbacker Intermodal Facility[1]	1,300	20,400	-	X	X		X
	Guild's Lake Industrial Sanctuary (Under Development)[1]	1,625	-	-	X	X	(X)	
	Heller Industrial Park[1]	-	-	-	X	X		
	Mesquite Intermodal Facility/Skyline Business Park[1]	400	-	-	X	X		
	Port of Huntsville[3]	1,780	-	-	X	X		X
	Pureland Industrial Complex[1]	3,000	-	150	X	X		(X)
	Raritan Center[1]	2,350	15,000	391	X	X		
	Winter Haven[1]	1,250	8,000	-	X	X		

†X refers to inside the facility and (X) refers to in the vicinity.
[1](Boile et al., 2008)
[2](Weisbrod et al., 2002)
[3](Walter and Poist, 2004)
[4](de Cerreno et al., 2008)
[5](Leitner & Harrison, 2001)

Table 9. Articles with respect to their scope, method, and dimension

Scope	Category	Dimension	Article	References
General	Assessment	Impact	1	Hamzeh et al. (2007)
		Financial	2	Tsanmboulas et al. (2003), Meidutė et al. (2007)
		Location	2	Kayikci (2010), Marković et al. (2013)
	Design	Environ. Impact	1	Altuntas et al. (2013)
		Governance	1	Wu et al. (2011)
		Network Design	1	Cassone et al. (2010)
		Definition	2	Meidutė (2005), Rimienė et al. (2007)
		Other	1	Wiegmans et al. (1999)
Case Based - Country Level	Assessment	Efficiency	2	Somogyi et al. (2011), Haralanbides et al. (2012)
		Identifying Metrics	1	Tsamboulas et al. (1999)
		Location	3	Ruying et al. (2008), Zak et al. (2014), Roso et al. (2015), Onden et al. (2015)
		Environ. Impact	2	Hanaoka et al. (2011), Lättilä et al. (2013)
		Flexibility	1	Abrahamsson et al. (2003)
		Regional Development	1	Monios (2015)
		Other	1	Jaržemskis (2007)
	Design	Governance	2	Winkler et al. (2011), Witte et al. (2014)
		Size	1	Zheng et al. (2012)
		Action Plan	1	Giannopoulos (2008)
		Quality	1	Vural et al. (2015)
		Other	12	FV-2000 (2000), Tsukai et al. (2001), Han (2008), Rodrigue et al. (2010), Eryuruk et al. (2011), Long et al. (2011), Andrejić et al. (2013), Antai et al. (2013), Calis et al. (2014), Bodaubayeva (2015), Monios et al. (2015), Liu et al. (2015)
Case Based - Individual	Assessment	Efficiency	5	Kapros et al. (2005), Carvalho et al. (2010), DGG (2010), Yue et al. (2011), Yang et al. (2015)
		Feasibility	7	Labanuskas et al. (2007), Afandizadeh et al. (2008), Boile et al. (2008), DiJohn et al. (2009), Antún et al. (2010), Lima Jr. et al. (2010), Higgins et al. (2011)
		Regional Development	2	Sainz et al. (2013), Vrochidis (2013)
		Other	5	Tánczos et al. (2000), Hesse (2004), Bergqvist (2008), FAL Bulletin (2011), Eckhardt et al. (2012)
	Design	Location	5	Eryuruk et al. (2011), Regmi et al. (2013), Elevli (2014), Bergqvist et al. (2008), Eryuruk et al. (2012)
		Governance	1	Monios (2015)
		Risk Mgmt.	1	Breuer et al. (2012)
		Size	2	Ballis (2005), Ballis et al. (2007)
		Other	3	Hesse (2004), Weisbrod et al. (2002), Wu et al. (2013)

Table 10. Articles with multiple dimensions

Scope	Category	Dimension	Wiegmans et al. 1999	Tsamboulas et al. 1999	FV 2000	TÁNCZOS et al. 2000	Tsukai et al. 2001	Weisbrod et al. 2002	Hesse 2004	Jarżemskis 2007	Bergqvist 2008	Han 2008	Rodrigue et al. 2010	Bulletin FAL 2011	Eryuruk et al. 2011	Long et al. 2011	Eckhardt et al. 2012	Andrejić´ et al. 2013	Antai et al. 2013	Wu et al. 2013	Calis et al. 2014	Monios et al. 2015	Liu et al. 2015	Bodaubayeva 2015
General	Design	Environ. Impact			X																			
		Governance	X																					
		Network Design			X																			
		Definition	X																					
		Size	X																					
Case Based Country Level	Assessment	Efficiency		X			X			X								X						
		Identifying Metrics		X														X						
		Environ. Impact								X														
		Flexibility								X									X					X
		Regional Development																						X
	Design	Governance			X						X	X	X		X				X		X	X	X	X
		Size			X						X	X			X	X		X			X	X	X	X
		Action Plan			X						X				X							X		
		Quality			X							X			X									
		Location			X		X				X		X		X	X		X	X		X		X	X
		Network Design			X		X														X			
Case Based Individual	Assessment	Efficiency				X								X			X							
		Feasibility				X																		
		Regional Development												X										
		Environ. Impact												X										
	Design	Location				X		X	X															
		Governance				X		X	X											X				
		Risk Mgmt.																		X				
		Size						X	X															
		Network Design				X			X											X				
		Knowledge Sharing															X			X				
		Definition															X							